MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, GENERAL PURPOSE
TX AND NON-TX TYPES
1N5835 and 1N5836

1. SCOPE

1.1 Scope. This specification covers the detail requirements for silicon, general purpose semiconductor diodes for use as power rectifiers in equipment circuits and is in accordance with MIL-S-19500, except as otherwise specified herein. The prefix "TX" is used on devices submitted to and passing the special process-conditioning, testing, and screening as specified in 4.6 through 4.6.9.

1.2 Physical dimensions. See figure 1.

1.3 Maximum ratings.

Type	V_R	V_{RM}(wkg)	I_o @ T_A = -65 to +55°C 1/ 3/	I_o @ T_A = 100°C 2/ 3/	if(surge) @ I_o=2Adc T_A=+100°C t_p=8.3mSec	if(surge single cycle) @ T_A=25°C t_p=8.3mSec	trr	$R_{\theta JL}$ (.375 from body)
	Vdc	V	Adc	Adc	Apk	Apk	Nsec	°C/W
1N5835	30	30	3.0	2.0	50	150	100	20
1N5836	50	50	3.0	2.0	50	150	100	20

1/ From 3A at T_A = +55°C, to 2A at T_A = +100°C, derate linearly at 0.022A/°C.
2/ From 2A at T_A = +100°C, to 0A at T_A = +200°C, derate linearly at 0.020A/°C.
3/ No heat sink or forced air shall be permitted across the body of the device.

OPERATING JUNCTION TEMPERATURE: -193.8°C to +200°C
STORAGE AMBIENT TEMPERATURE: -193.8°C to +200°C
BAROMETRIC PRESSURE, REDUCED: 8 mm Hg (100,000 feet)

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARDS

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. Requirements for the diodes shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500, and as follows:

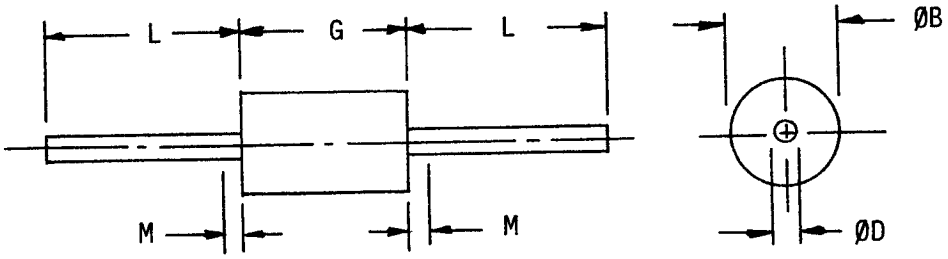
$R_{\theta JL}$ - - - - Thermal resistance, junction to lead.

3.3 Design, construction, and physical dimensions. The diode shall be of the design, construction, and physical dimensions specified in figure 1.

3.3.1 Encapsulant material. In addition to those categories of hermetically sealed package requirements specified in MIL-S-19500, fused-metal-oxide to metal shall also be acceptable.

3.3.2 Diode construction. The silicon die shall be metallurgically bonded directly to the terminal pins. The minimum silicon die size after etch shall be 0.115 inches diameter.

3.4 Performance characteristics. Performance characteristics shall be as specified in Tables I, II, and III.



LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
ØB	.135	.165	3.43	4.19	3
ØD	.038	.042	.96	1.07	
G	.140	.165	3.56	4.19	
L	.900	1.100	22.86	27.94	
M	-0-	.050	-0-	1.27	4

NOTES:

1. Dimensions are in inches.
2. Metric equivalents (to the nearest .01mm) are given for general information only and are based upon 1 inch = 25.4mm.
3. Dimension ØB shall be measured at the largest diameter.
4. Dimension M lead diameter uncontrolled in this area.

FIGURE 1. Semiconductor device, diode 1N5835 and 1N5836, TX and Non-TX types.

3.4.1 Process-conditioning, testing, and screening for "TX" types. The procedure for process-conditioning, testing, and screening the "TX" types shall be as specified in 4.6 through 4.6.9.

3.5 Marking. The following marking specified in MIL-S-19500 may be omitted at the option of the manufacturer:

(a) Manufacturer's identification.
(b) Country of origin.
(c) Inspection lot identification code.

3.5.1 Polarity. The polarity shall be indicated with a contrasting-color band to denote the cathode end.

3.5.2 Marking of the type number. Marking of the type number on more than one line is permissible. The break in the type number can be as follows:

JAN		JTX
1NX	or	1NX
XXX		XXX

4. QUALITY ASSURANCE PROVISIONS

4.1 General. Application for qualification inspection shall be in accordance with "Provisions Governing Qualification SD-6." In addition to those requirements covered in "Provisions Governing Qualification," the manufacturer shall submit a sample diode and detail drawings of the diode showing the dimensions of the internal piece parts along with the letter requesting permission to qualify.

4.2 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.3 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.

4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests shown in table I, and shall be performed on an inspection sublot of each type.

4.3.2 Group B inspection. Group B inspection shall consist of the examinations and tests shown in table II. Subgroups 1, 2, 3, and 4 of group B inspection may be performed on an inspection sublot of any type to qualify all types. Subgroup 5 of group B inspection shall be performed on an inspection sublot of the highest-voltage type being qualified.

4.3.3 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table III. Subgroups 1 and 4 of group C shall be performed on the highest-voltage type to qualify all types. Subgroups 2, 3, and 5 of group C inspection may be performed on an inspection sublot of any type to qualify all types.

4.3.4 Group B life tests inspection. Group B inspection life tests shall consist of the examinations and tests shown in table II, subgroups 6 and 7. Inspection shall be performed on an inspection sublot of the highest-voltage diode types being qualified. Life test duration shall be 1000 hours and the lambda (λ) established in table II shall apply.

4.4 Quality conformance inspection. Quality conformance inspection shall consist of examinations and tests specified in groups A, B, and C inspections.

4.4.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I. Group A inspection shall be conducted on an inspection sublot of each type.

4.4.2 Group B inspection. Group B inspection shall consist of the examinations and tests shown in table II. Subgroups 1, 2, 3, 4, and 5 of group B inspection may be performed on an inspection sublot of any type to qualify all types.

4.4.3 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table III and shall be performed on every tenth lot or every 6 months, whichever comes first. Subgroups 1 and 4 of group C shall be performed on the highest-voltage type to qualify all types. Subgroups 2, 3, and 5 of group C inspection may be performed on an inspection sublot of any type to qualify all types. If a lot contains a higher-voltage type than has previously been accepted to subgroups 1 and 4 in the current 6 month period, this higher-voltage type shall be subjected to subgroups 1 and 4 inspection.

4.4.4 Group B life tests inspection. Group B inspection life tests shall consist of the examinations and tests shown in table II, Subgroups 6 and 7. Inspection shall be performed on a sublot of the highest and lowest voltage types present in the lot. "TX" and "Non TX" diode types shall be subjected to 1000 hour life tests and the lambda (λ) established in table II shall apply. Once the "Non TX" lot has passed the 1000 hour test, life tests with minimum of 340 hours may be initiated for new lots provided those lots are exempted from the table III, group C, testing requirements (see 4.4.3).

4.5 Methods of examination and test. Methods of examination and test shall be as specified in tables I, II, and III, and as follows:

4.5.1 Reverse recovery time. The reverse recovery time shall be measured in the circuit of figure 2, or equivalent. The recovery conditions shall be 0.5A forward current to 1.0A reverse current. The reverse recovery time is defined as the time the rectifier begins to conduct in the reverse direction (crosses I = zero) until the reverse current decays to -0.25A. The point of contact on the leads shall be no less than 3/8 inch from the diode body.

4.5.2 Thermal shock (temperature cycling). Samples that have been subjected to the group B thermal shock test may be continued on test to 25 cycles in order to satisfy group C thermal shock test requirements. These samples shall be predesignated, and shall remain subjected to the group C 25 cycle acceptance evaluation after they have passed the group B 10 cycle acceptance criteria. The cumulative total of failures found during the 10 cycle test and during the subsequent interval up to 25 cycles shall be computed for 25 cycle acceptance criteria.

4.5.3 Thermal resistance. Thermal resistance shall be measured in accordance with figures 3 and 4. The high-temperature point shall be 100°C. The low-temperature test shall be performed at room-ambient conditions with the device mounted to an infinite heat-dissipator. The heat-dissipator shall be attached to the leads at a distance "L"=0.375 inches from the body of the device. The diode under test shall be protected in such a manner that no draft nor forced-air shall flow across the body of the device.

4.5.4 Steady state operation life test. This test shall be conducted with a half-sine waveform of the specified peak voltage impressed across the diode in the reverse direction, followed by a half-sine waveform of the specified average rectifier current. The forward conduction angle of the rectified current shall not be greater than 180° nor less than 150° and the power shall be equal to or greater than that of a half-sine wave. Mounting method shall utilize a clip type connection; no heat sink nor forced-air flow across the body of the device shall be employed.

4.5.5 Resistance to solvents. The diodes shall be subjected to tests in accordance with method 215 of MIL-STD-202 and as follows:

(a) All areas of the diode body where marking has been applied shall be brushed.

(b) After completion of the tests, there shall be no evidence of mechanical damage to the device, and markings shall have remained legible.

4.6 Process-conditioning, testing, and screening for "TX" types. The procedure for process-conditioning, testing, and screening the "TX" types shall be in accordance with 4.6.1 through 4.6.9 and figure 5. Process-conditioning shall be conducted on 100 percent of the lot prior to submission of the lot to the tests specified in tables I, II, and III. (At the option of the manufacturer, the non-TX type may be subjected to process-conditioning and testing.)

4.6.1 High-temperature storage. All devices shall be stored for at least 48 hours at a minimum temperature (TA) of +200°C.

4.6.2 Thermal shock (temperature cycling). All devices shall be subjected to thermal shock (temperature cycling) in accordance with MIL-STD-750, method 1051, test condition C, except that cycling duration shall be ten continuous cycles and exposure time at temperature extremes shall be fifteen minutes (minimum).

4.6.3 Acceleration. All devices shall be subjected to the acceleration test in accordance with MIL-STD-750, method 2006, with the following exceptions: The test shall be performed one-time in the Y_1 orientation only, at a peak level of 20,000 G (minimum). The one-minute hold-time requirement shall not apply.

4.6.4 Hermetic-seal tests. All cavity devices shall be subjected to hermetic-seal tests as specified in 4.6.4.1 and 4.6.4.2 or 4.6.4.3. All non-cavity devices shall be subjected to hermetic-seal tests as specified in 4.6.4.2 or 4.6.4.3.

4.6.4.1 Hermetic seal (fine-leak) test. All devices shall be fine-leak tested in accordance with MIL-STD-750, method 1071, test condition G or H.

4.6.4.2 Hermetic seal (gross-leak) test (bubble). All devices shall be tested for gross leaks in accordance with MIL-STD-750, method 1071, test condition D, except that the solution may be any suitable noncorrosive liquid at a minimum temperature of 100°C.

4.6.4.3 Hermetic seal (gross-leak) test (penetrant dye). All devices shall be tested for gross leaks in accordance with MIL-STD-750, method 1071, test condition E. For non transparent devices use pure isopropyl alcohol in lieu of dye penetrant and test electrically to the I_R limit of table I in lieu of visual examination.

TABLE I. Group A inspection

Examination or Test	MIL-STD-750		LTPD		Symbol	Limits		Unit
	Method	Details	Non TX	TX		Min.	Max.	
Subgroup 1			5	5				
Visual and mechanical examination	2071				---	---	---	---
Subgroup 2			5	3				
Forward voltage	4011	i_f=3.0A(pk); duty cycle≤2% (pulsed); t_p≤8.3ms			V_f	0.70	0.90	V(pk)
Reverse current	4016	DC method			I_R			
1N5835		V_R=30Vdc				---	1.0	µAdc
1N5836		V_R=50Vdc				---	1.0	µAdc
Subgroup 3			5	3				
High temperature operation:		T_A=+100°C						
Reverse current	4016	DC method			I_R			
1N5835		V_R=30Vdc				---	20	µAdc
1N5836		V_R=50Vdc				---	20	µAdc
Subgroup 4			10	10				
Reverse recovery time	---	(See 4.5.1 and figure 2.)			t_{rr}	---	100	nSec

TABLE II. Group B inspection

Examination or Test	MIL-STD-750		LTPD		Symbol	Limits		Unit
	Method	Details	Non TX	TX		Min.	Max.	
Subgroup 1			10	10				
Physical Dimensions	2066	(See figure 1.)			---	---	---	---
Subgroup 2			10	10				
Solderability	2026				---	---	---	---
Soldering heat	2031	20 cycles per lead dwell time = 10Sec			---	---	---	---
Thermal shock (Temperature cycling)	1051	Test cond. C, 10 cycles (See 4.5.2)			---	---	---	---
Thermal shock (glass strain)	1056	Test cond. B: low temp.-65°C high temp.+200°C			---	---	---	---
Terminal strength (tension)	2036	Test cond. A: Wgt = 5 lbs; t = 15 sec			---	---	---	---
Hermetic seal	1071	Test cond. G or H for fine leaks; test cond. D or E for gross leaks (See 4.6.4)			---	---	---	---
Moisture resistance	1021	Omit initial conditioning			---	---	---	---
End points:								
Forward voltage	4011	i_f=3.0A(pk); duty cycle≤2% (pulsed); t_p=8.3ms			V_f	0.70	0.90	V(pk)
Reverse current	4016	DC method			I_R			
1N5835		V_R=30Vdc				---	1.0	µAdc
1N5836		V_R=50Vdc				---	1.0	µAdc
Reverse recovery time	---	(See 4.5.1 and figure 2.)			trr	---	100	nSec

TABLE II. Group B inspection

Examination or Test	MIL-STD-750		LTPD		Symbol	Limits		Unit
	Method	Details	Non TX	TX		Min.	Max.	
Subgroup 3			10	10				
Shock	2016	Nonoperating; 2,500G; 5 blows of 0.5 ms each, in orientations: X_1, Y_1, and Y_2 (total = 15 blows)			---	---	---	---
Vibration, variable frequency	2056	Nonoperating			---	---	---	---
Constant acceleration	2006	20,000G; orientation Y_1						
End points: (Same as subgroup 2 of group B.)								
Subgroup 4			10	10				
Terminal strength (lead fatigue)	2036	Test cond. E; weight = 2 lbs			---	---	---	---
Subgroup 5			10	5				
Surge current	4066	i_F(surge)=50A(pk) 10 surges of 8.3 ms each at 1-min. intervals, superimposed on I_O=2Adc; V_{RM}(wkg)=rated (see 1.3) T_A=+100°C			---	---	---	---

TABLE II. Group B inspection

Examination or Test	MIL-STD-750		LTPD		Symbol	Limits		Unit
	Method	Details	Non TX	TX		Min.	Max.	
Subgroup 5 (Cont.)			10	5				
Surge current (single cycle)	4066	if(surge) = 150A (pk), one surge of 8.3 ms I_O=0 $V_{RM(wkg)}$=0 T_A=25°C			---	---	---	---
End points: (Same as subgroup 2 of group B.)								
Subgroup 6			λ=5	λ=3				
High temperature life (nonoperating)	1031	T_A=+200°C t=340 hrs for Non-TX only (See 4.4.4)			---	---	---	---
End points: (Same as subgroup 2 of group B plus tests)								
Reverse current change	---				ΔI_R	---	±250	nAdc
Forward voltage change	---				ΔV_f	---	±0.1	V(pk)
Subgroup 7			λ=5	λ=3				
Steady-state operation life	1026	See 4.5.4 I_O=3Adc; f=60Hz; $V_{RM(wkg)}$=rated T_A=25°C t=340 hours for Non-TX only (See 4.4.4)						
End points: (Same as subgroup 6 of group B)								

TABLE III. Group C inspection

Examination or Test	MIL-STD-750		LTPD		Symbol	Limits		Unit
	Method	Details	Non TX	TX		Min.	Max.	
Subgroup 1			7	5				
Barometric pressure (reduced)	1001	Pressure (see 1.3) t=1 minute (min.)			---	---	---	---
Measurement during test:								
Reverse current	4016	DC method			I_R			
1N5835		VR=30Vdc				---	1.0	µAdc
1N5836		VR=50Vdc				---	1.0	µAdc
Thermal shock (temperature cycling)	1051	Test cond. C, 25 cycles; time at temperature extremes - 15 mins total test time = 72 hours maximum (see 4.5.2)			---	---	---	---
End points: (Same as Subgroup 2 of Group B)								
Subgroup 2			10	7				
Salt atmosphere (corrosion)	1041				---	---	---	---
Subgroup 3			10	10				
Resistance to solvents	---	Method 215 of MIL-STD-202 (see 4.5.5)			---	---	---	---
End points: (Same as Subgroup 2 of Group B)								
Subgroup 4			7	5				
Low temperature operation		T_A=-193.8°C						

TABLE III. Group C inspection

Examination or Test	MIL-STD-750		LTPD		Symbol	Limits		Unit
	Method	Details	Non TX	TX		Min.	Max.	
Subgroup 4 (Cont.)								
Forward voltage	4011	i_f=3.0A(pk); duty cycle≤2%(pulsed); t_p=8.3 ms			V_f	0.85	1.05	V(pk)
High temperature operation:		T_A=+100°C						
Forward voltage	4011	i_f=3.0A(pk); duty cycle≤2%(pulsed); t_p=8.3 ms			V_f	0.65	0.85	V(pk)
Subgroup 5			7	5				
Thermal resistance		(See 4.5.3 and figures 3 and 4) L=0.375"			$R_{\theta JL}$	---	20	°C/W

4.6.5 Preburn-in tests. The parameters V_F and I_R of table IV shall be measured and the data recorded for all devices in the lot. All devices shall be handled or identified such that the delta end points can be determined after the burn-in test. All devices which fail to meet these requirements shall be removed from the lot and the quantity removed shall be noted on the lot history.

TABLE IV. Burn-in test measurements

Examination or Test	MIL-STD-750		Symbol	Limits		Unit
	Method	Details		Min.	Max.	
Forward voltage	4011	if=3.0A(pk); duty cycle≤2%(pulsed; t_p=8.3 ms	Vf	0.70	0.90	V(pk)
Reverse current	4016	DC method (at T_A = room ambient)	I_R			
1N5835		V_R=30Vdc		---	1.0	µAdc
1N5836		V_R=50Vdc		---	1.0	µAdc
Reverse recovery time	---	(See 4.5.1 and figure 2.)	t_{rr}	---	100	nSec

4.6.6 Burn-in test. All devices shall be operated for 164 hours (minimum) under the following conditions (see 4.5.4):

T_A = 25°C V_{RM}(wkg) = full rated (see 1.3)

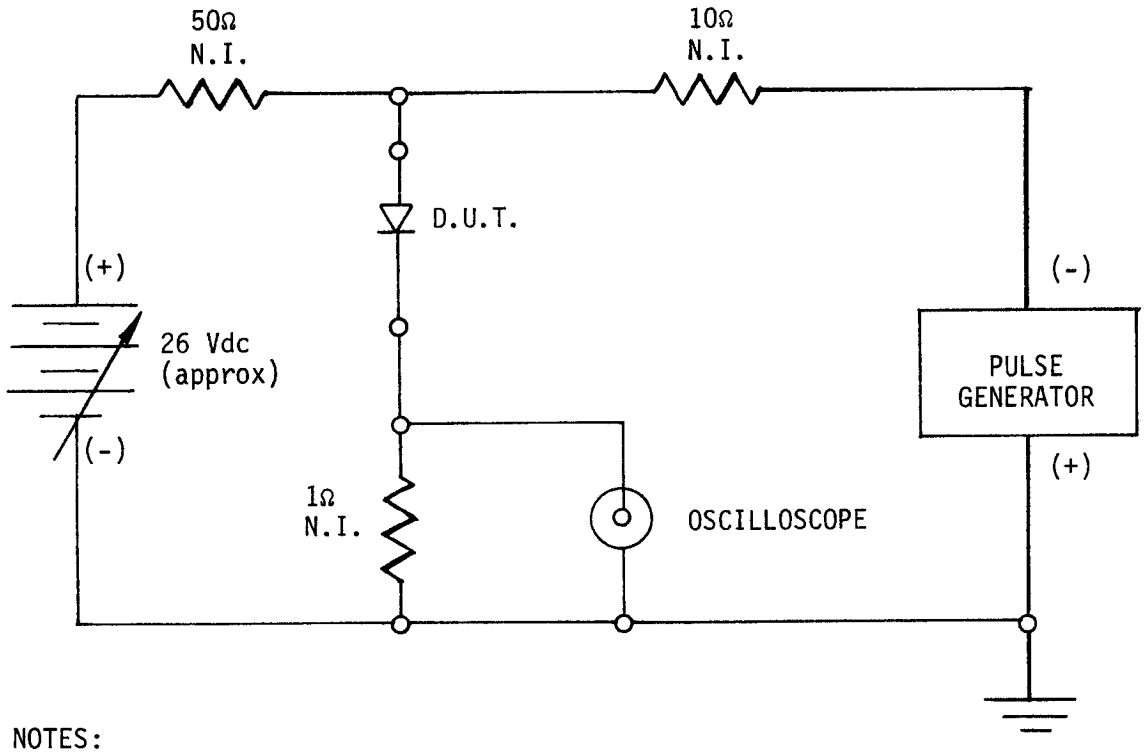
I_O = 3 Adc f = 60 Hz

4.6.7 Post burn-in tests. The parameters V_F, I_R and t_{rr} of table IV shall be retested within 24 hours after burn-in and the data recorded for all devices in the lot. The V_F and I_R parameters measured shall not have changed during the burn-in test from the initial value by more than the specified amount as follows:

ΔV_F = ±0.1 Vdc

ΔI_R = ±250 nanoamperes (maximum)

4.6.8 Scope-display evaluation. The reverse breakdown characteristics shall be viewed on an oscilloscope with display calibration factors of 5 to 20 µA/division and 5 to 10 V/division. Reverse current over the knee shall be at least 50 µA. Each device shall exhibit a sharp knee characteristic and any discontinuity or dynamic instability of the trace shall be cause for rejection.



NOTES:
1. Oscilloscope: Rise time ≤ 7 ns; input impedance = 1 Meg; 22pF.
2. Pulse Generator: Rise time ≤ 10 ns; source impedance = 50Ω.

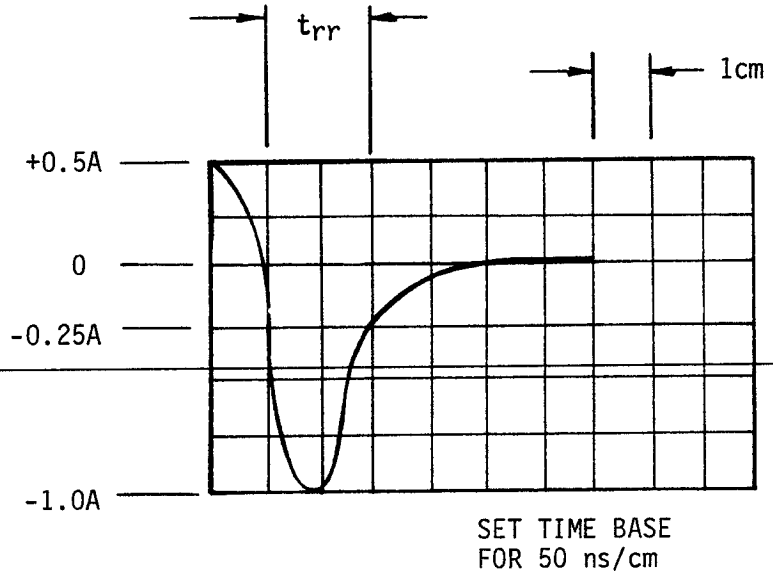
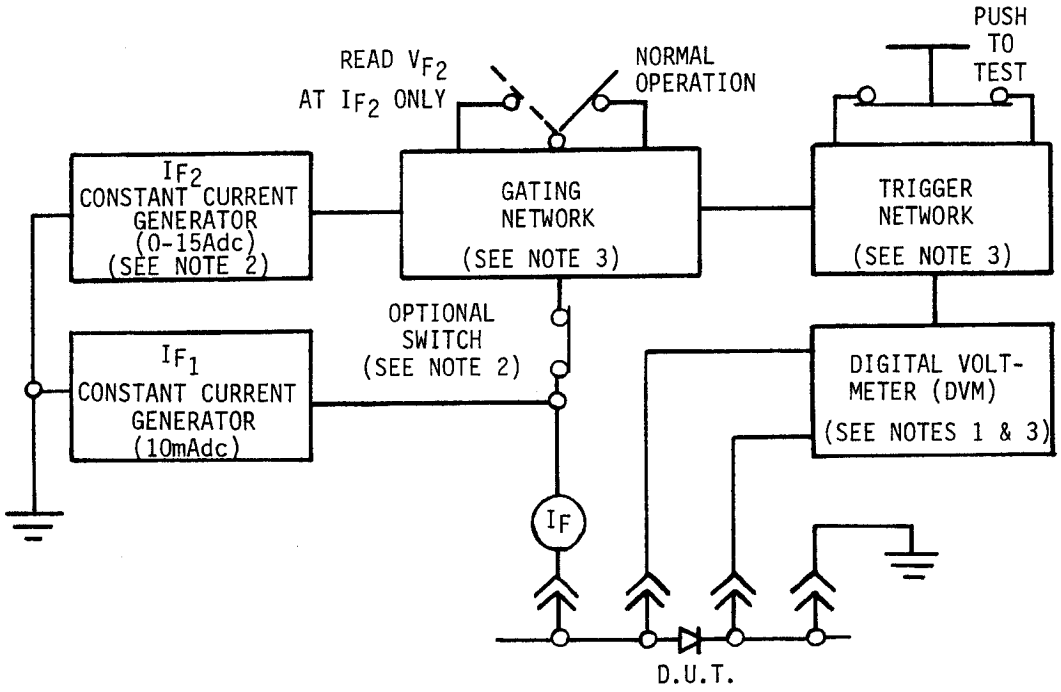


FIGURE 2. Reverse-recovery time test circuit and characteristic waveform.



NOTES:
1. The same digital voltmeter must be used for all V_F readings.
2. I_{F2} generator must be turned off or switched out of circuit for testing V_{F1} at I_{F1} at 100°C.
3. The trigger network, gating network, and digital voltmeter must be capable of operating within the time limits specified in the timing diagram. (see figure 4.)

PROCEDURE:
(a) Place diode under test in high temperature test fixture. Read and record V_{F1} at I_{F1} (10 mAdc) at T_A=100°C (see notes 1 and 2). Diode must be permitted to stabilize until junction temperature reaches 100°C.
(b) Place diode in infinite heat-dissipator mounting at room-ambient conditions (approximately 25°C). The diode shall be mounted with infinite heat dissipators located 0.375" from the body of the device.
(c) Apply I_{F2} (0-15 Adc supply) and allow to stabilize for ≥ 30 seconds. Depress push to test switch and read V_{F1} at I_{F1}. Compare V_{F1} at T_A (room ambient) reading with data recorded for V_{F1} at T_A (100°). (See timing diagram, figure 4.)
(d) Gradually increase I_{F2}, taking readings as described in procedure (c), until V_{F1} at T_A (room ambient) = V_{F1} at T_A (100°C).
(e) Read and record V_{F2} and I_{F2}.
(f) Calculate θ:

$$\theta = \frac{T_1 - T_2}{\text{watts}} = \frac{T_A(100^\circ C) - T_A\ (\text{room ambient})}{V_{F2} \cdot I_{F2}} = \frac{\sim 75^\circ C}{V_{F2} \cdot I_{F2}} = \text{Thermal impedance junction to lead in } ^\circ C/W.$$

FIGURE 3. Thermal resistance test, functional block diagram.

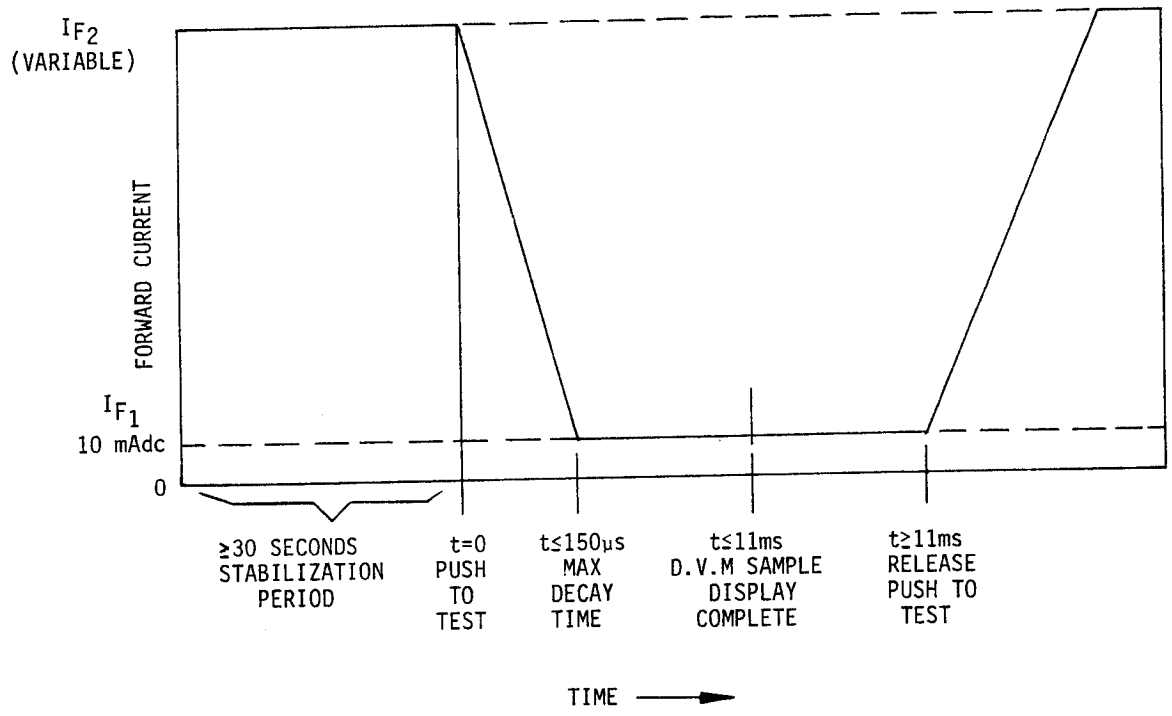


FIGURE 4. Timing diagram for thermal resistance test.

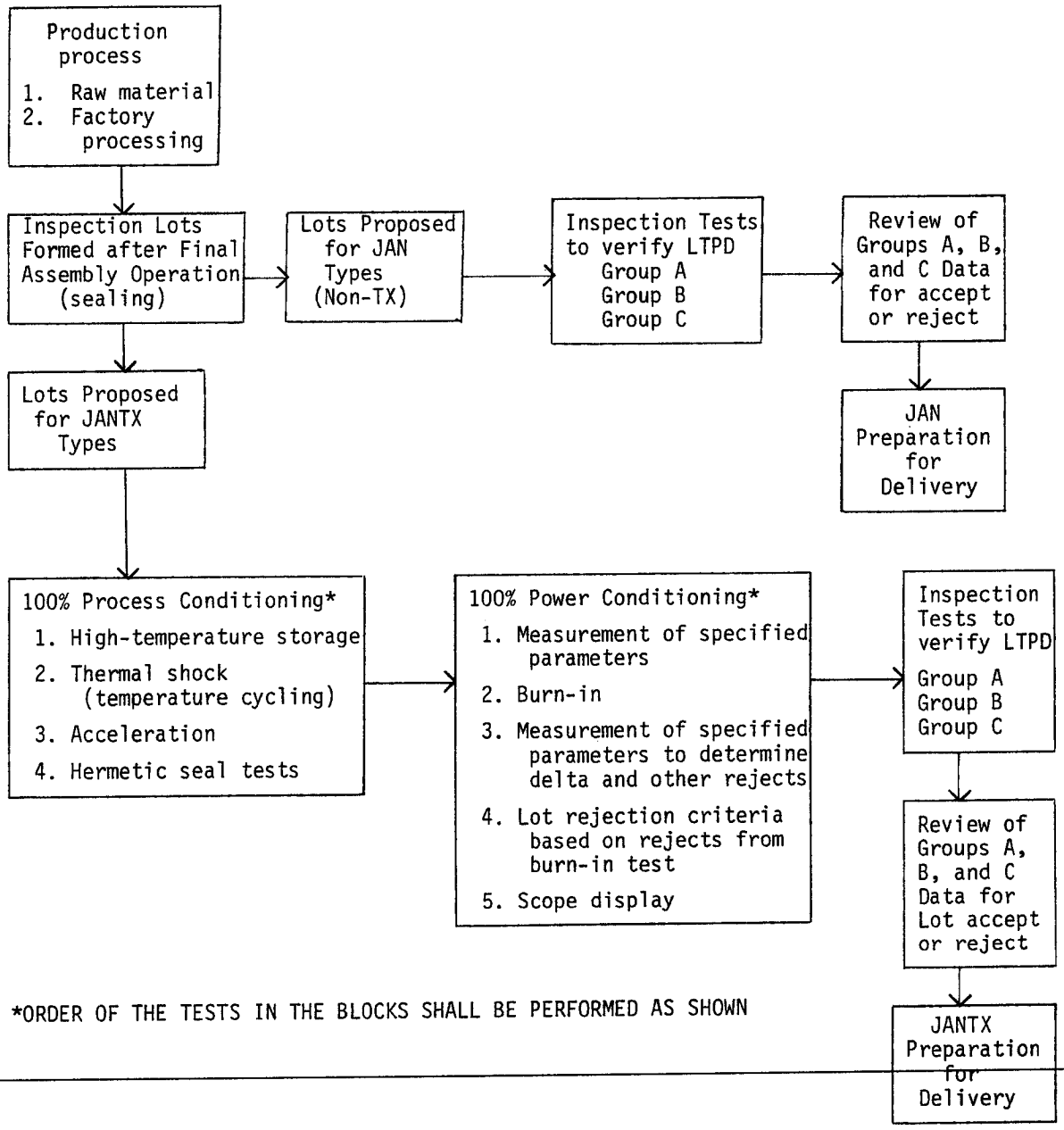
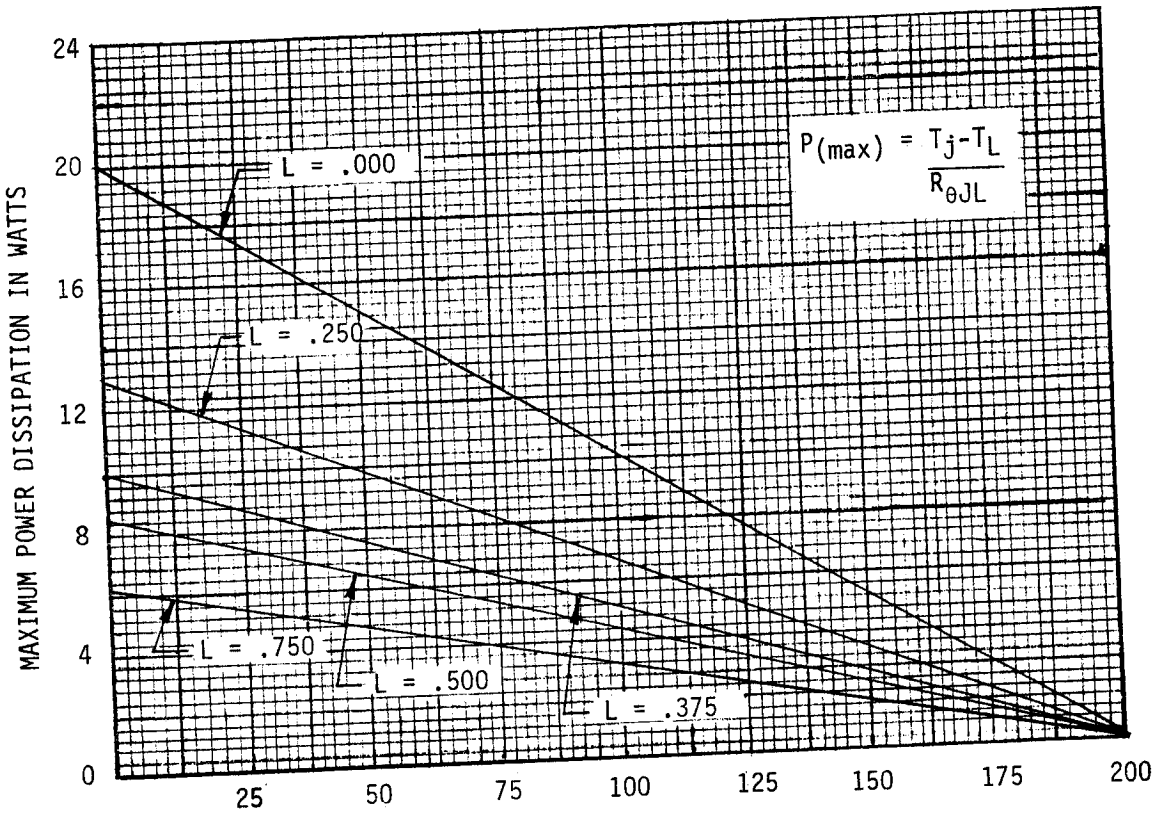


FIGURE 5. Order of procedure diagram for JAN (Non-TX) and JANTX types.



Maximum lead temperature in °C (T_L) at point "L" from body (For maximum operating junction temperature of 200°C with equal two-lead conditions).

L	$R_{\theta JL}$
INCHES	°C/W
.000	10
.250 (6.35)	15
.375 (9.53)	20
.500(12.70)	24
.750(19.05)	33

NOTES:
1. Dimensions are in inches.
2. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.

FIGURE 6. Maximum power in watts vs lead temperature.

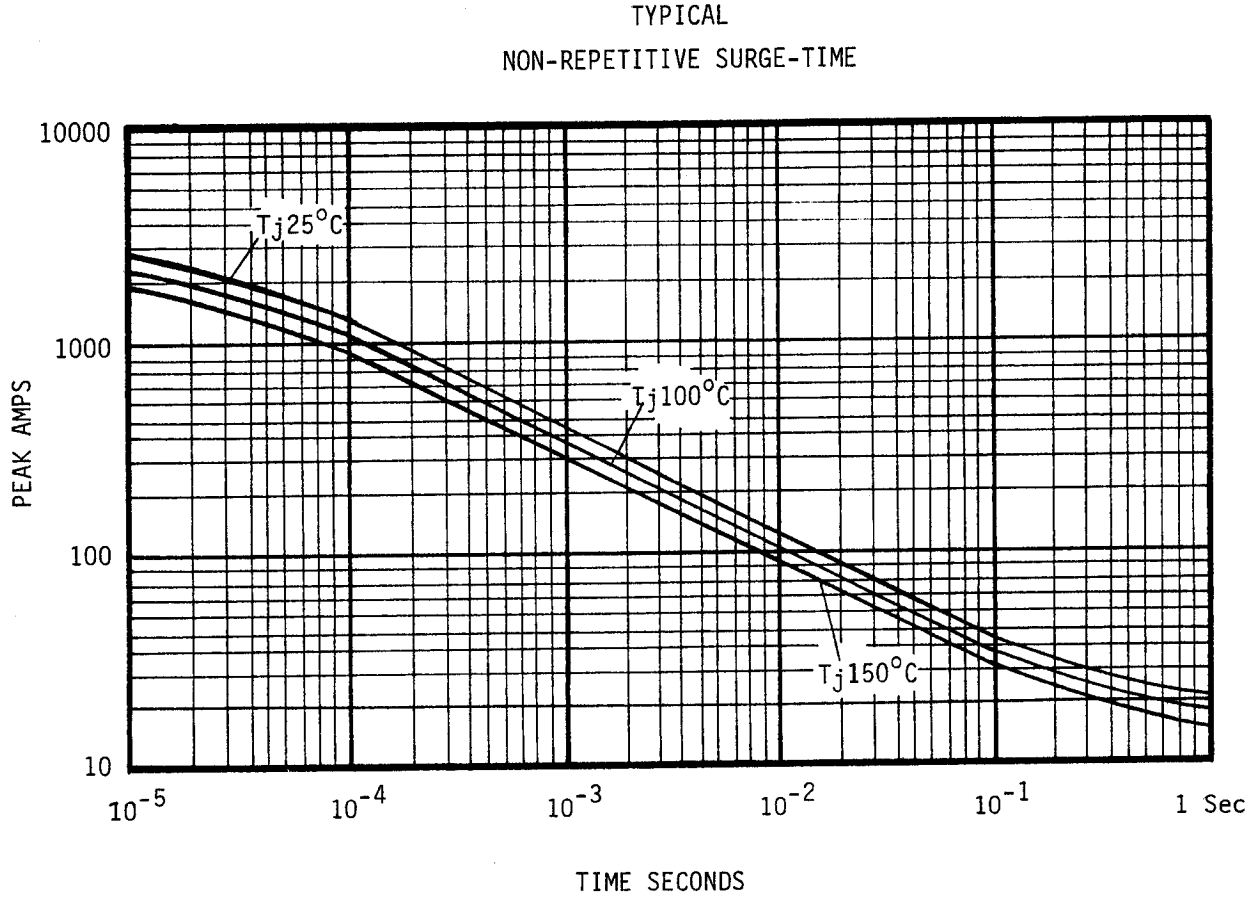


FIGURE 7. Typical non-repetitive surge current in amps vs. time in seconds.

4.6.9 Burn-in test failure (screening). All devices that exceed the delta (Δ) limits of 4.6.7 or the limits of those tests performed on table IV or fail scope-display evaluation (see 4.6.8), shall be removed from the inspection lot and the quantity removed shall be noted on the lot history. Where the quantity removed after burn-in exceeds 10 percent of the total inspection lot on burn-in test, the entire lot shall be unacceptable as "TX" types.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery. Preparation for delivery shall be in accordance with MIL-S-19500.

6 NOTES

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Applications Data.

6.2.1 Thermal impedance. Device power capability with lead-dissipators or body forced-air-cooling, may be determined from figure 6, which shows maximum power dissipation in watts versus lead temperature in ^{o}C at a distance "L" from the diode body.

6.2.2 Non-repetitive surge time. Device surge capability may be determined from Figure 7, which shows typical surge current in peak amps versus time in seconds.

Custodians:

Army - EL

Preparing activity:

Army - EL

Project No. 5961-A497